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SOFTWARE FOR DIGITIZING SPONTANEOUS COMBUSTION CURVES

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SOFTWARE FOR DIGITIZING SPONTANEOUS COMBUSTION CURVES

by

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ABSTRACT

In this report, a FORTRAN computer program used to digitize curves obtained in crossing point spontaneous combustion tests using a Calcomp 9000 series digitizer is described. The method used in running this program is detailed. The structure of the input/output files is also described.

The developed digitizing routine is required to provide input data to the "Spontaneous Combustion" model, presently under development by the Surface Mining Laboratory Environmental Research group in Devon. This program is a general Fortran routine that can be used to digitize a two-dimensional curve and also to insert the data in a file for processing.

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LOGICIEL DE CONVERSION EN NUMÉRIQUE DES COURBES DE COMBUSTION SPONTANÉE

par

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RÉSUMÉ

Le présent rapport décrit un programme FORTRAN utilisé sur un numériseur Calcomp de la série 9000 pour la conversion en numérique de courbes obtenues dans des essais de combustion spontanée à point de croisement. La méthode utilisée pour l'exécution du programme est décrite en détail. La structure des fichiers d'entrée/sortie est aussi décrite.

Le progamme de conversion en numérique élaboré est requis en vue de fournir des données d'entrée au modèle de "combustion spontanée", qui est présentement élaboré par le groupe de recherche environnementale du Laboratoire d'exploitation en surface de Devon. Ce programme est un programme FORTRAN général permettant de convertir en numérique une courbe bidimensionnelle et d'insérer les données dans un fichier en vue du traitement.

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INTRODUCTION

Data obtained from crossing point tests are in the form of a continuous curve of temperature as a function of time (1-3). Presently this is obtained by using a chart-recorder (4). In the existing form it is not possible to analyze these data to obtain some parameters that are useful in characterizing coals with respect to their susceptibility to spontaneous combustion. Therefore these curves are digitized in the form of discrete data points using a CalComp 9000 digitizer (5). This digitizer employs magnetic principles of coupling to resolve positional coordinates. It converts the physical position of a cursor on an activated digitizer surface into a digital output that can be used for communication, processing and display purposes. This digitizer is connected to a Vax 11/750 minicomputer. To digitize a certain point on the graph, the cursor is placed on that point then the cursor button is depressed which directly dumps the data into a previously opened file in the Vax minicomputer. This report presents a Fortran computer program written to manipulate an input data file created on the Vax 11/750 using the digitizer. This program also corrects for origin of coordinates of the graph and for the scaling of axes. Details of this program are discussed in this report.

THE DIGITIZING ROUTINE

This program is designed to digitize a two-dimensional curve, it creates an output data file to be processed by a computer program called COAL.FOR. The latter is used to calculate some parameters to characterize coals with respect to their liability to spontaneous combustion. This program requires an input file that is created beforehand.

INPUT FILE

The digitizer is connected to a Vax minicomputer which is in turn connected to a VT100. After turning on the digitizer and the VT100, open a file and give it a name using the Edit command as in the following:

```
Edit coal.data
*C
```

The coal.data file is opened and is made available for inserting data into it. The curve is then digitized and data points are placed directly in the file by laying the cursor so that the cross hair is over the selected point on the curve then depressing one of the 16 buttons on the cursor except the asterisk button. The following outlines this procedure:

```
Edit coal.data
*C
-    1st digitized point
-    2nd digitized point
.
.
.
etc.
[ctrl z]
ex          to exit to terminal mode.
```

When either one of these buttons is depressed two control characters will precede the x and y coordinates of the digitized point. A carriage return is inserted after each data point to demand a new line. A typical example of two digitized points is as follows:

```
8D  3352 10241
8D  5041 11638
```

In each line, the second number (e.g. 3352 in line #1) gives the X-axis and the third number gives the Y-axis of the digitized point. The first two symbols (8D) given in front of the X and Y coordinates of each point are two control characters sent by the digitizer after depressing button 8 and of no value to us. Depressing button 7 will give the same X and Y coordinates for the digitized point precede it with 7D.

The origin of the coordinates of the graph is not (0,0) and has a certain value. Therefore the origin coordinates are recorded and each digitized point is corrected accordingly. Two data points of known dimension are also digitized one on the X-axis and the other on the Y-axis to be used to dimension data points of the graph.

An example of an input data file is given below:

```
COAL WET-AIR
8D  3368 10302
2
8D  3352 10241
8D  5041 11638
15
8D  3368 11744
8D  3891 11836
8D  4183 11937
8D  4889 12410
8D  5585 13114
8D  5821 13411
8D  6446 13987
8D  7114 14470
8D  8928 15524
8D 10116 16408
8D 11714 17909
8D 13164 20032
8D 13830 21330
8D 14272 22042
```

8D 15003 22943

In this example 1st, 3rd and 6th line were inserted later on file to indicate type of data, number of data points used to dimension the data and total number of digitized points. For carrying out a detailed mathematical analysis, it was found that fifteen data points are adequate to represent fully the curves for the coals under consideration. Therefore the number of data points handled by the program are limited to fifteen data points.

Output File

SPON1.for program reads the above file, ignores the first two symbols and corrects for origin coordinates and dimension all data points. In crossing point experiments our data is in the form of temperature as a function of time.

Lines 10 through 50 dimension temperature and time parameters and define input and output file names. Lines 60 and 70 requests for the name of input file. Lines 80 and 90 opens input and output files and gives the name Spon1.out to the output file.
Lines 100 through 150, 180 through 260 and 290 through 340 read the input file. Lines 350 through 480 corrects for the origin of the curve X0, Y0 and scales the data to be in the form of temperature as a function of time. Appendix 1 gives the listing

of Spon1.for program and an example of the output file is given in appendix 2.

CONCLUSIONS

A FORTRAN computer program to digitize two-dimensional curves using a Calcomp 9000 digitizer is presented. This program reqires opening an input file that is created using the Vax 11/750 minicomputer and the Calcomp digitizer. The output file created by this program is in the form of temperature as a function of time. This program is designed to digitize curves at twenty points but can easily be modified to handle any number of data points.

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2. Chakravorty, R.N., Kar, K. "Characterization of Western Canadian Coals with Respect to Their Susceptibility to Spontaneous Combustion"; Division Report ERP/CRL 86-151, CANMET, Energy Mines & Resources; 1986.

3. Mansour, N.A., Chakravorty, R.N., Stewart, D.B., Kar, K. "Interpretation of Thermograms to Determine Spontaneous Combustion Susceptibility of Coals"; Fifth International Pittsburgh Coal Conference; September 12-16, Pittsburgh; 731-741, 1988.

4. Thermo Electric Instruction and Maintenance Manual, Model 3511-3150-14, 1976.

5. Calcomp 9000 Series Digitizer Operator's Manual, Manual Number 50090-1, July 1983.

APPENDIX 1

Listing of SPON1.FOR program.

```
C       SPON1.FOR PROGRAM
C       THIS PROGRAM ACCEPTS X(TIME) AND Y(TEMP.) DATA OBTAINED
C       FROM SPON COMB. CURVES USING THE DIGITIZER AND CORRECTS
C       FOR ORIGIN COORDINATES XO & YO
10      INTEGER N,M,itim(20),item(20)
20      REAL XA(20),YA(20),TIME(20),TEMP(20)
30      CHARACTER*20 FNAME
40      CHARACTER*35 NAME
50      CHARACTER*2 D
60      WRITE(5,'(16H ENTER FILE NAME,$/)')
70      READ(5,'(A20)') FNAME
80      OPEN(UNIT=1,FILE=FNAME,STATUS='OLD')
90      OPEN(UNIT=3,FILE='SPON1.out',status='new')
100     READ(1,11)NAME
110  11 FORMAT(35A)
120     READ(1,12)I1,D,XO,YO
130  12 FORMAT(I1,A1,2X,F4.0,1X,F5.0)
140     XO=XO/100.0
150     YO=YO/100.0
160     WRITE(3,13)XO,YO
170  13 FORMAT(1H1,'XO=',F6.2,'YO=',F6.2)
180     READ(1,14)N
```

```
190  14   FORMAT(I2)
200       DO 1 I=1,N
210       READ(1,12)i1,d,XA(I),YA(I)
220       XA(I)=XA(I)/100.0
230  1    YA(I)=YA(I)/100.0
240       READ(1,14)M
250       WRITE(3,33)NAME
260  33   format(1h ,35a)
270       WRITE(3,15)N,M
280  15   FORMAT(1HO,'N=',I2,'M=',I2)
290       DO 2 J=1,M
300       READ(1,99)I1,D,ITIM(J),ITEM(J)
310       TIME(J)=ITIM(J)/100.0
320       print*,'time=',time(j)
330  2    TEMP(J)=ITEM(J)/100.0
340  99   FORMAT(I1,A1,1X,I5,1X,I5)
350       DO 22 J=1,M
360  22   WRITE(3,16)TIME(J),TEMP(J)
370  16   FORMAT(1HO,2x,F10.5,2X,f10.5)
380       XAV=XA(1)-XA(2)
390       YAV=YA(2)-YA(1)
400       WRITE(3,17)XAV,YAV
410  17   FORMAT(1HO,'XAV=',F10.5,'YAV=',F10.5)
420       DO 4 J=1,M
430       TEMP(J)=((TEMP(J)-YO)/YAV)*25.0
440  4    TIME(J)=((TIME(J)-XO)/XAV)*40.0
C    -------------------------------
450       WRITE(3,18)
460  18   FORMAT(1H ,'TIME',5X,'TEMP')
470       DO 44 I=1,M
480  44   WRITE(3,16)TIME(I),TEMP(I)
490       STOP
500       END
```

APPENDIX 2

An example of SPON1.FOR output data file in the form of temperature as a function of time.

coal	wet-air
0.0	25.81
12.38	27.45
19.30	29.26
36.02	37.72
52.50	50.32
58.09	55.63
72.89	65.94
88.72	74.59
131.68	93.45
159.81	109.27
197.66	136.13
232.00	174.12
247.77	197.35
258.24	210.09
275.55	226.22